

# Vadose Zone Characterization of B-BX-BY Waste Management Area and Surrounding Disposal Facilities, Hanford Site, Washington

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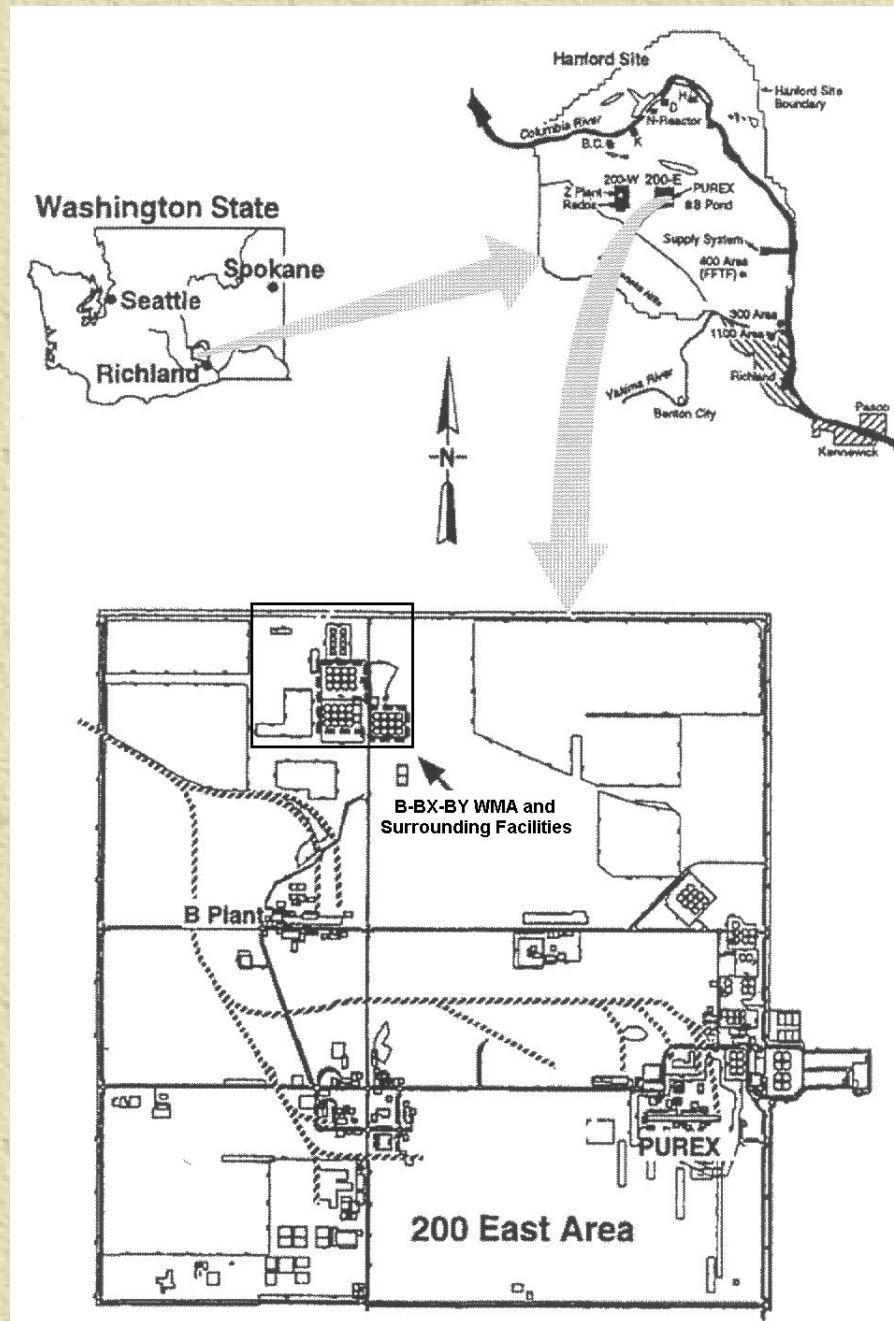
S.M. Sobczyk, P.D. Henwood, and R.G. McCain  
S.M. Stoller Corporation\*  
Richland, Washington

J.M. Silko  
U.S. Department of Energy Richland Operations Office  
Richland, Washington

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**Locations of B-BX-BY  
Waste Management  
Area and Surrounding  
Waste Disposal  
Facilities at Hanford  
Site (modified from  
Narbutovskih 2000)**

# Background

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- ✧ DOE Grand Junction Office asked by DOE Richland Operations Office in 1994 to establish baseline vadose zone characterization project at Hanford single-shell tank farms
- ✧ Project utilized geophysical logging capabilities and experience established during former National Uranium Resource Evaluation (NURE) program
- ✧ Logged 769 boreholes and completed baseline characterization of Hanford single-shell tank farms from 1995 to 2000
- ✧ Initiated baseline characterization logging in waste disposal sites of Hanford 200 Areas in 2001

# Waste Disposal Site Baseline Characterization

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- ✱ Employs same data analysis, interpretation, and reporting methodology as tank farm baseline characterization
- ✱ Integrates log data from all available boreholes to interpret subsurface contamination
- ✱ Assembles pre-baseline (historical) log data and compares to baseline to assess contaminant stability over time
- ✱ Completed logging in 2002 of more than 260 boreholes in B-BX-BY Waste Management Area and surrounding waste disposal facilities in 200 East Area of Hanford Site



# Capabilities of Logging Systems

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## ✦ Spectral Gamma Logging System (SGLS)

- ◆ HPGe detectors (liquid nitrogen cooled)
- ◆ 35% and 70% relative efficiencies
- ◆  $10^{-1}$  to  $10^4$  pCi/g ( $^{137}\text{Cs}$ )

## ✦ High Rate Logging System (HRLS)

- ◆ 8-mm x 6-mm “planar” HPGe detector (liquid nitrogen cooled)
- ◆ Internal and external shields to extend range
- ◆  $10^3$  to  $10^9$  pCi/g ( $^{137}\text{Cs}$ )

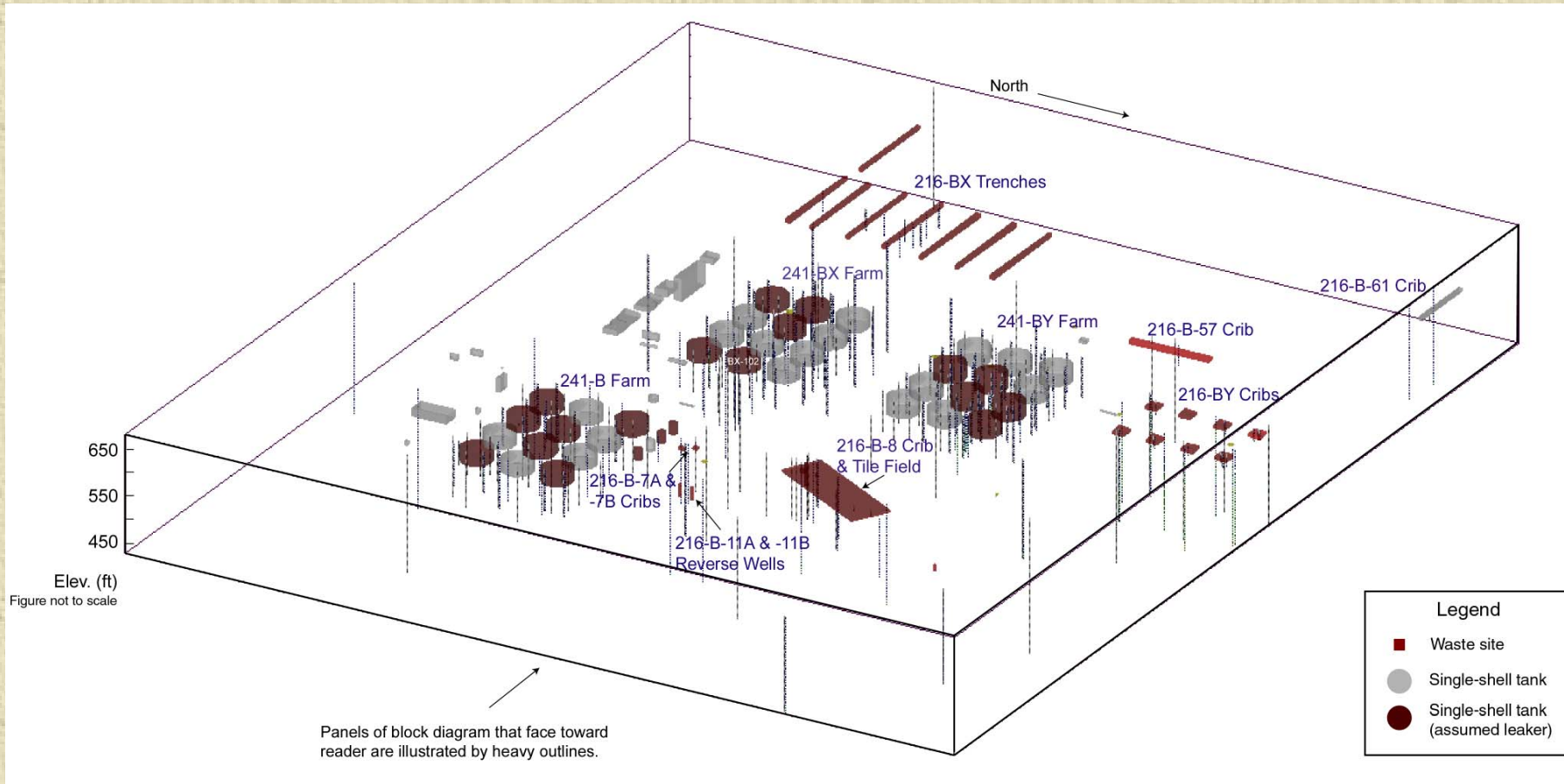
# Capabilities (continued)

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## ✠ Neutron Moisture Logging System (NMLS)

- ◆ Standard moisture gauge with AmBe source and  $^3\text{He}$  detector
- ◆ Specialized calibration functions for determination of volumetric moisture content in 6-in. and 8-in. steel-cased boreholes
- ◆ Not part of baseline characterization

# B-BX-BY Waste Management Area, Surrounding Waste Disposal Facilities, and Boreholes





# BX Tank Farm Under Construction

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# Types of Waste Disposal Facilities Near B, BX, and BY Tank Farms

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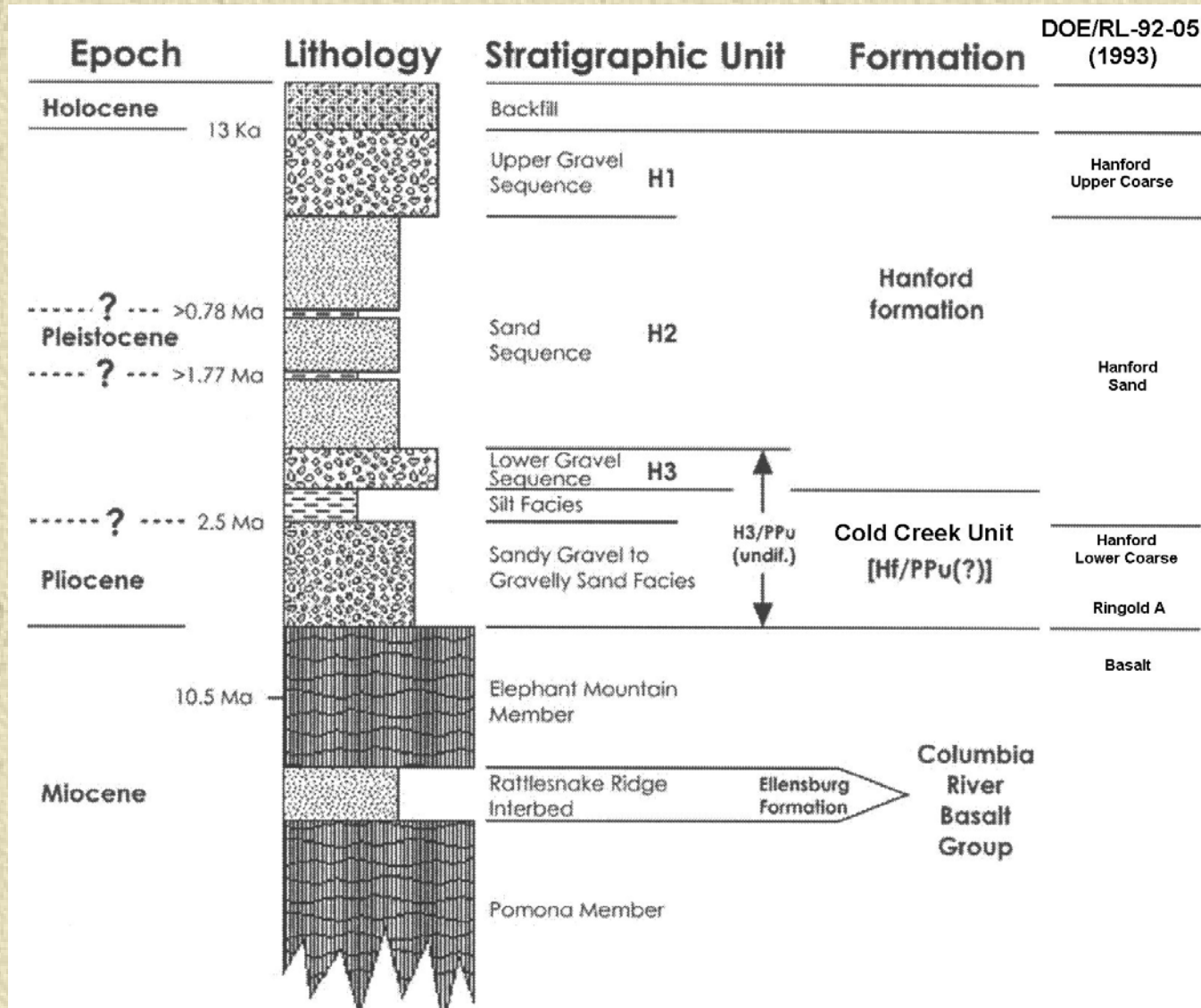


- ✦ Trenches
- ✦ Cribs and tile fields
- ✦ French drains
- ✦ Reverse wells
- ✦ Unplanned releases (UPRs)

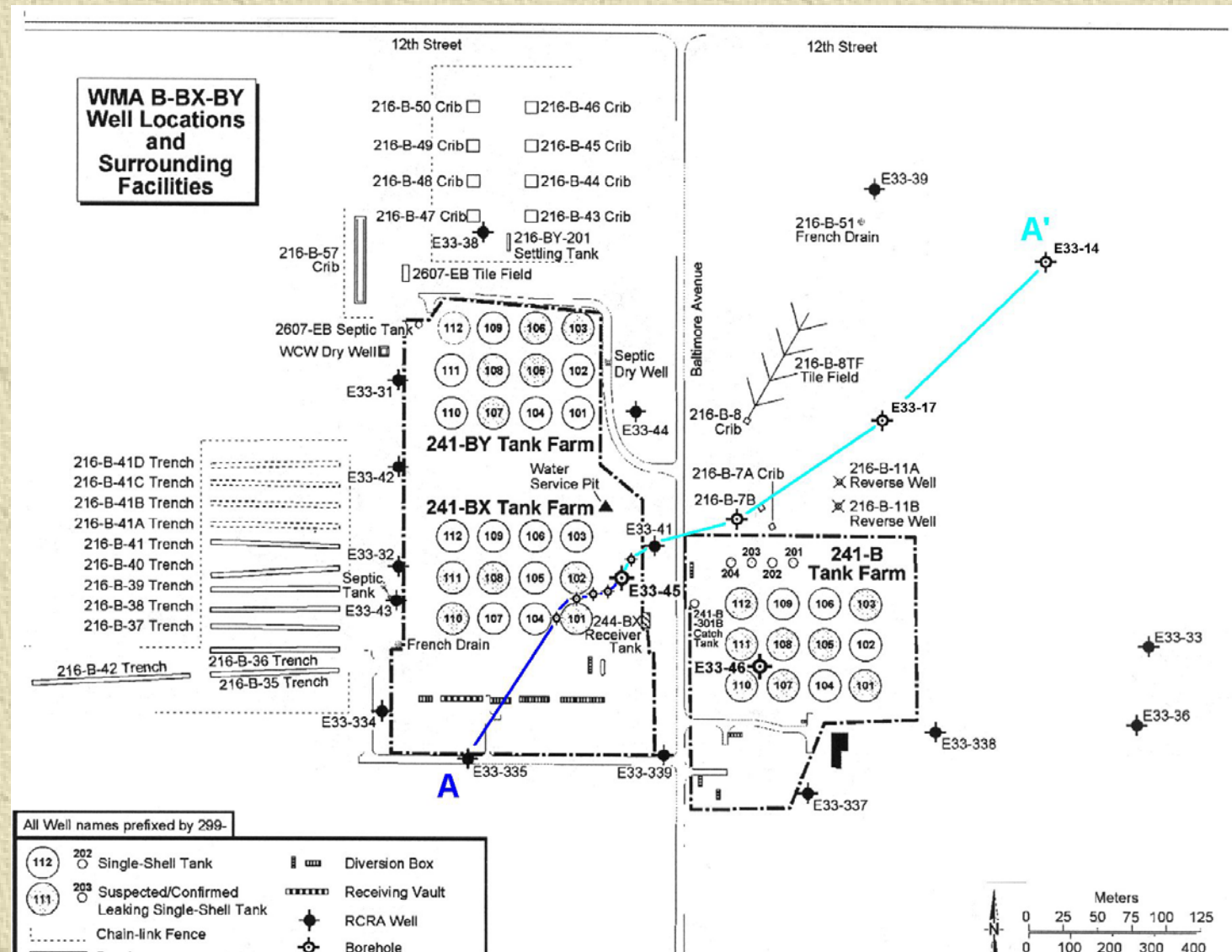
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# General Stratigraphy of B-BX-BY Waste Management Area (modified from Wood et al. 2000)



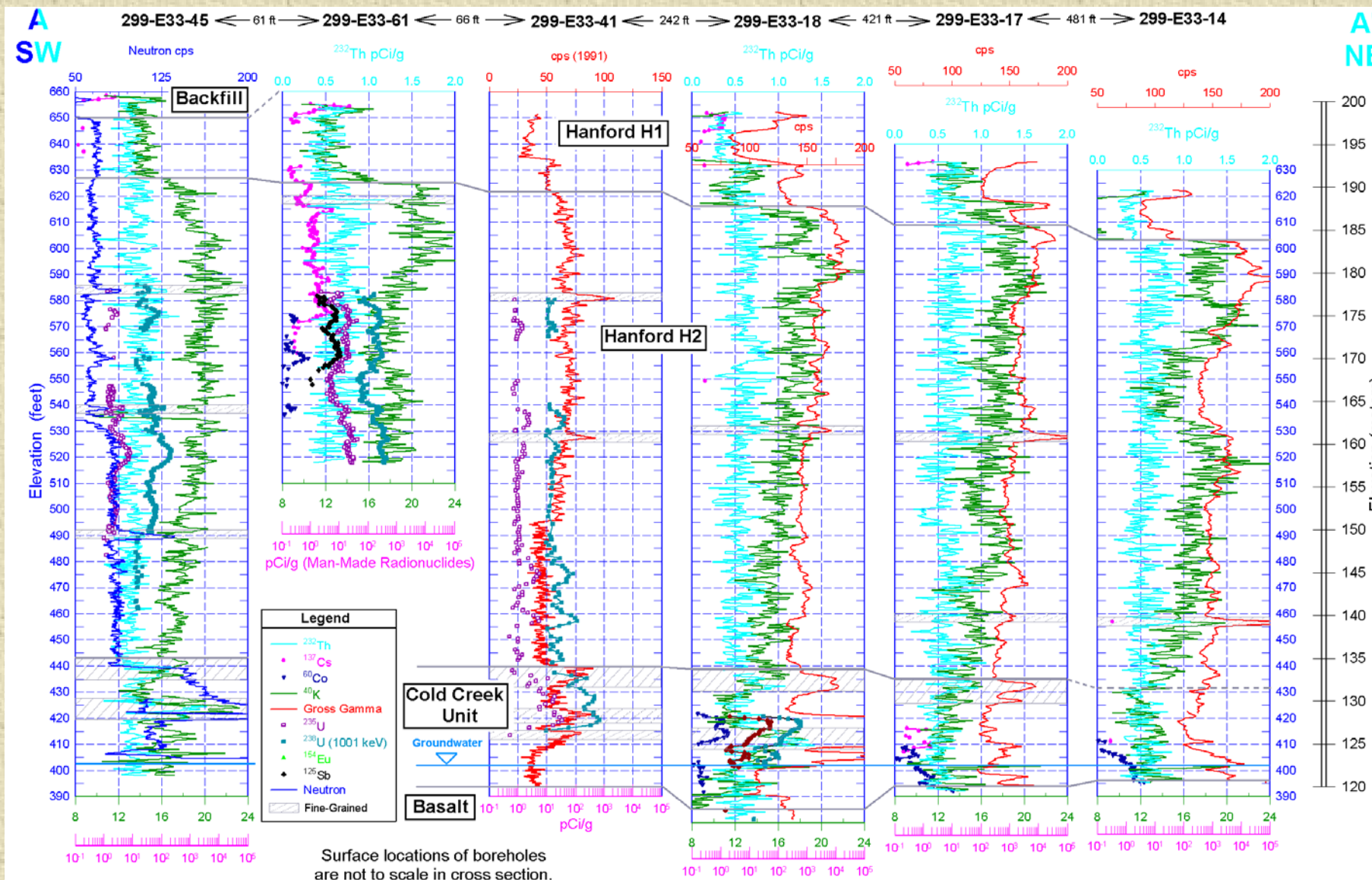
# B-BX-BY Waste Management Area, Surrounding Waste Disposal Facilities, and Location of Cross Section A-A' (modified from Horton 2002)





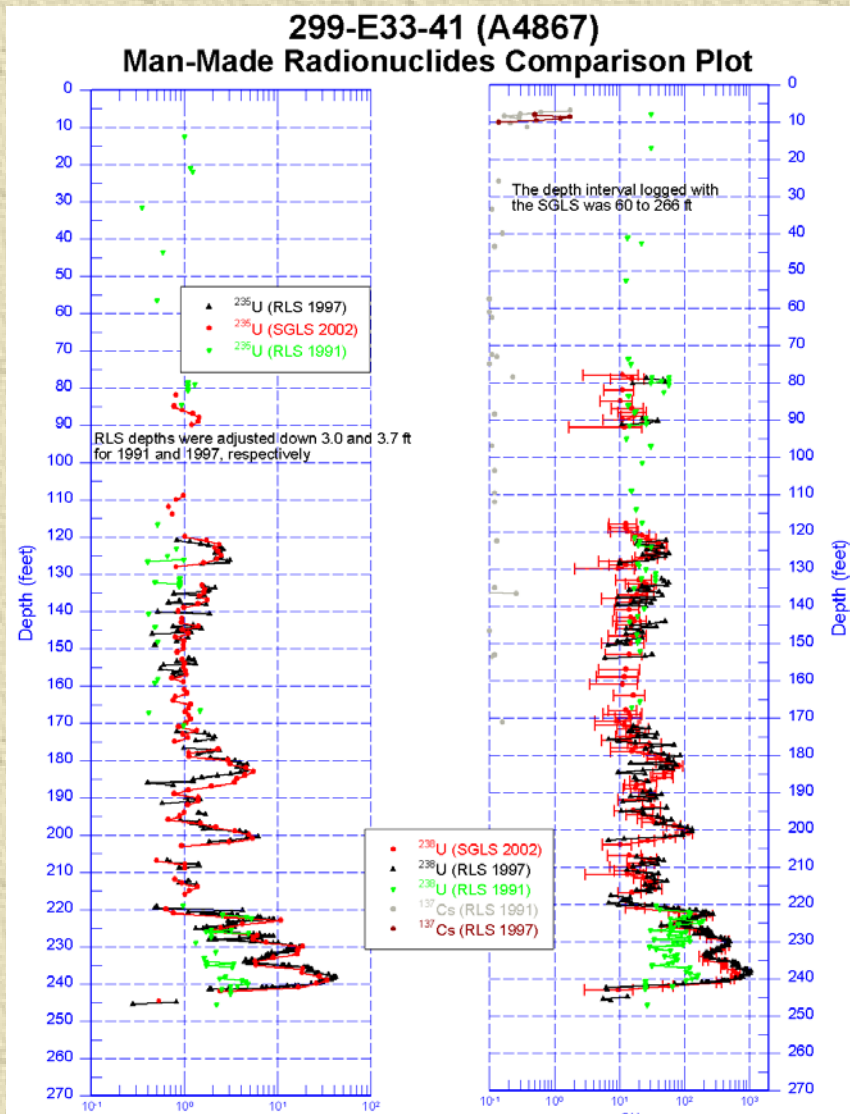


# Cross-Section A-A' (continued): B-BX-BY Area and Surrounding Waste Disposal Facilities



# Borehole 299-E33-41

## SGLS Compared to Prior Logging

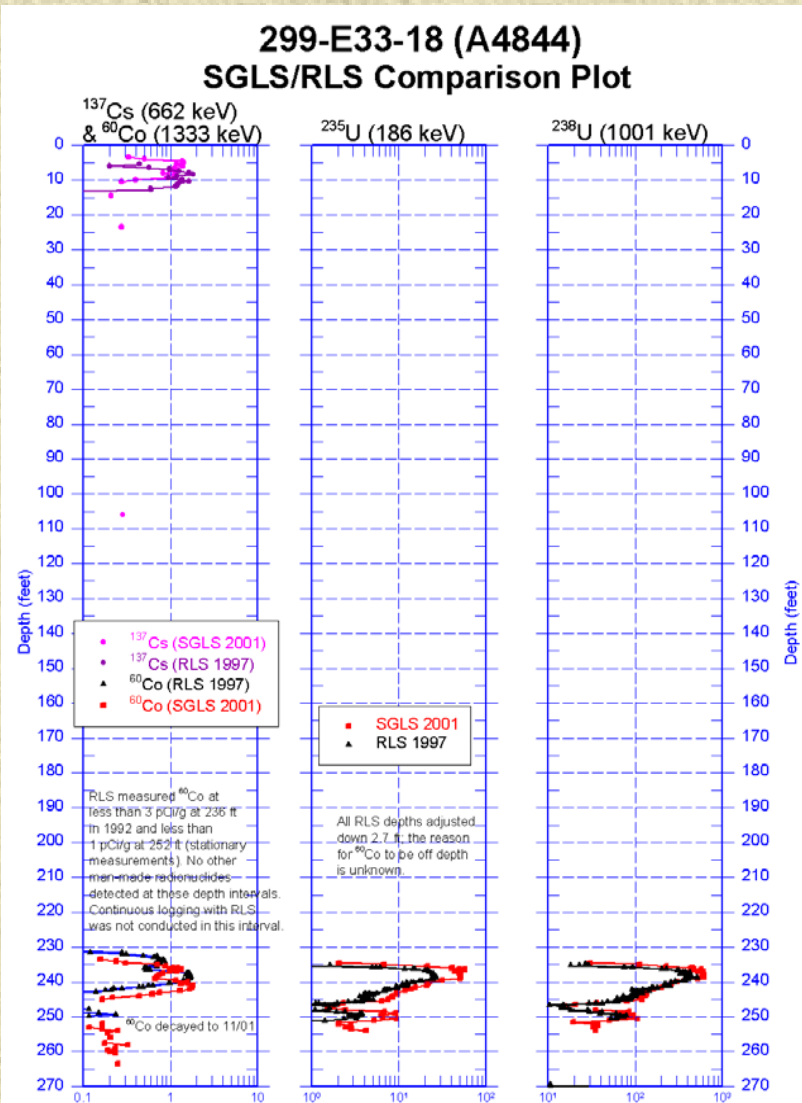


- ✦ Logged in 1991, 1997, and 2002
- ✦ Radionuclide Logging System (RLS) used in 1991 and 1997
- ✦ Significant influx of uranium contamination between log depths of 120 and 247 ft
- ✦ Influx occurred between 1991 and 1997



# Borehole 299-E33-18

## SGLS Compared to Prior Logging



- ✦ Logged in 1992, 1997, and 2002
- ✦ 1992 gross gamma log indicated high total counts between log depths of 230 and 242 ft
  - ✦ Based on the gross gamma log, RLS used to take stationary measurements for 300 s at 236 and 252 ft
  - ✦ 60Co detected at both depths at less than 3 pCi/g
  - ✦ No other man-made radionuclides detected

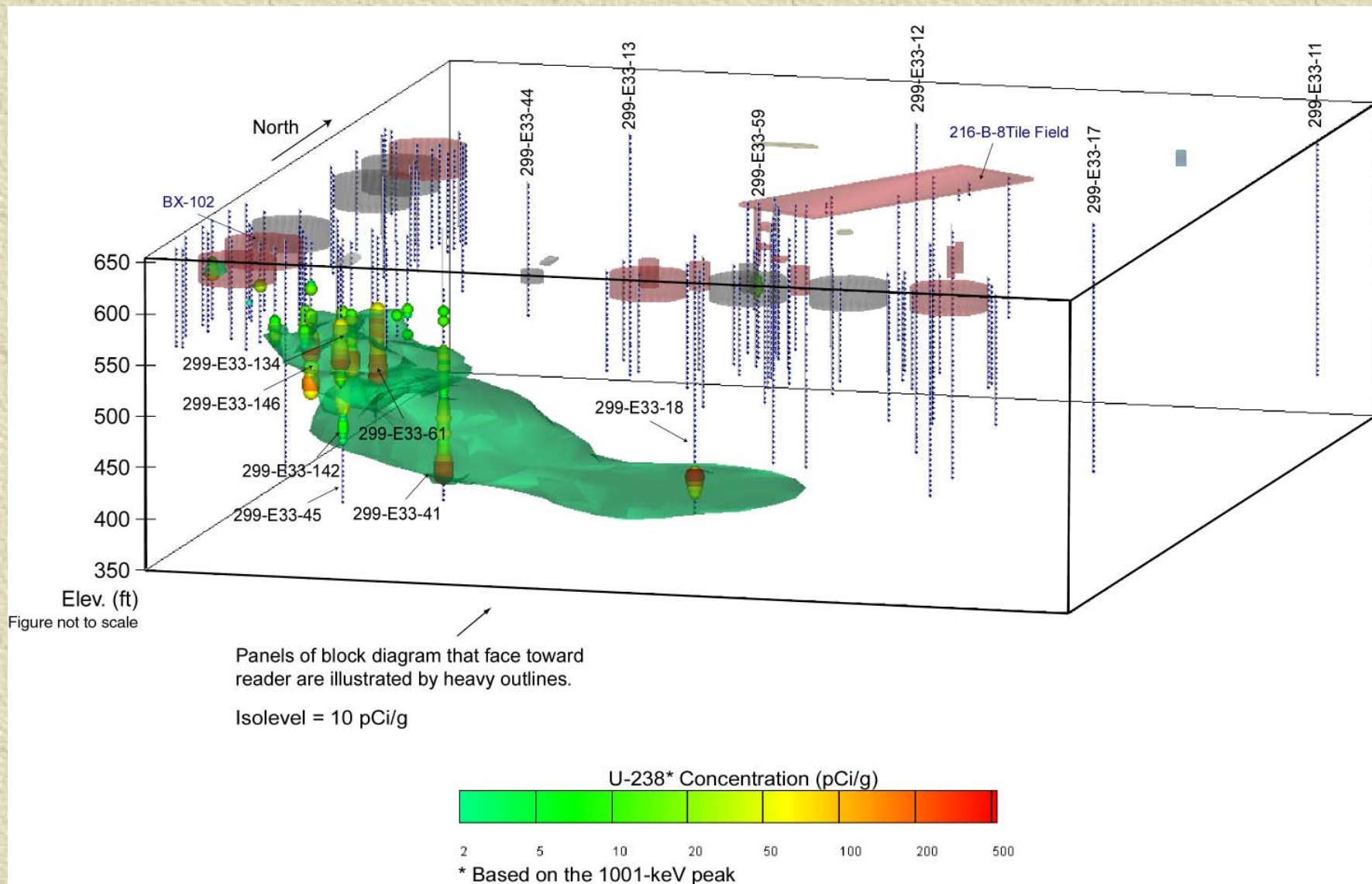


# Borehole 299-E33-18 SGLS Compared to Prior Logging (continued)

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- ✠ Uranium detected in 1997 and 2002 at log depths between 234 and 254 ft
  - ◆ Influx of uranium occurred between 1992 and 1997
  - ◆ Possible increase between 1997 and 2002

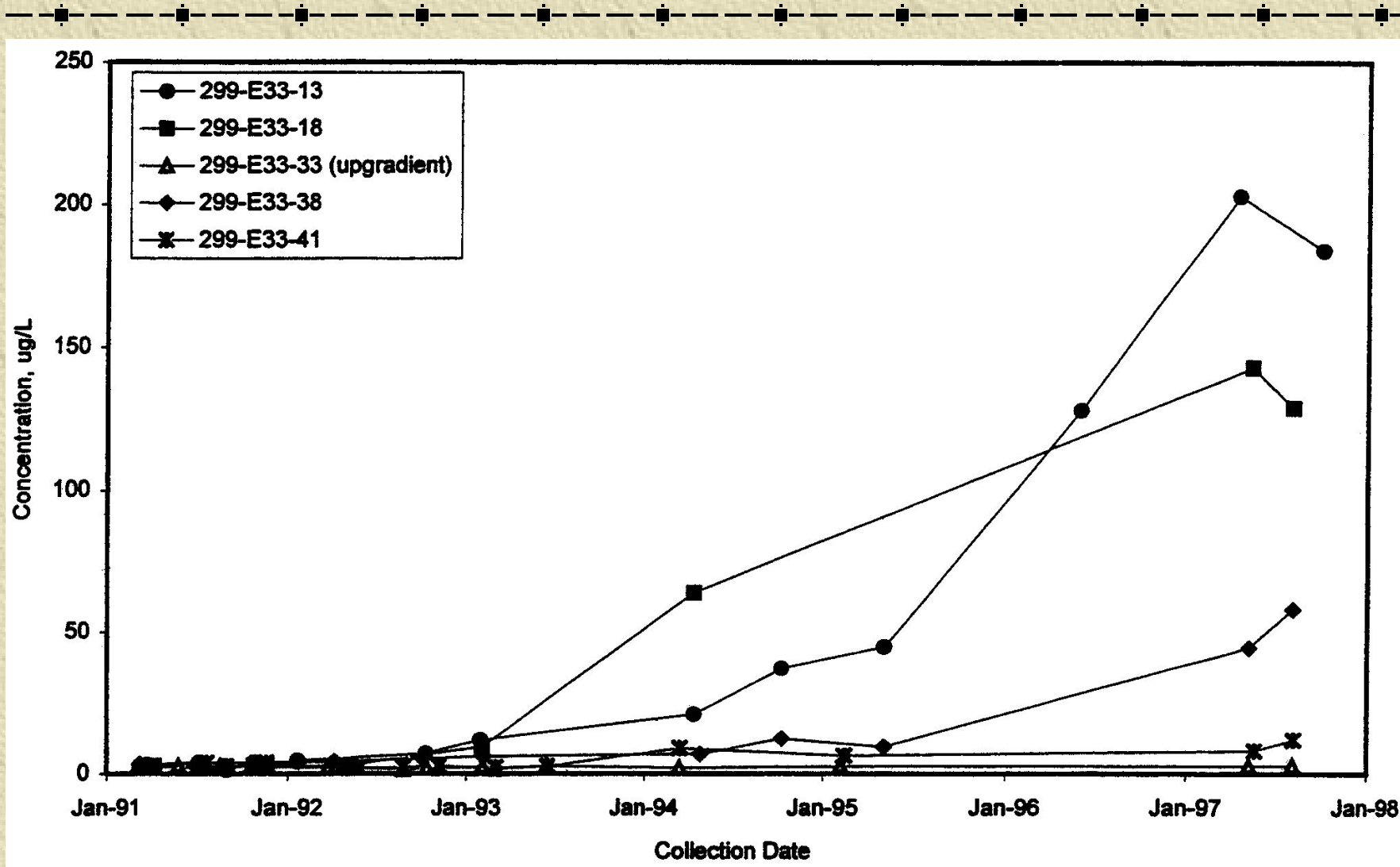
# Visualization of $^{238}\text{U}$ Contamination Near Tank BX-102 (modified from DOE 2002)





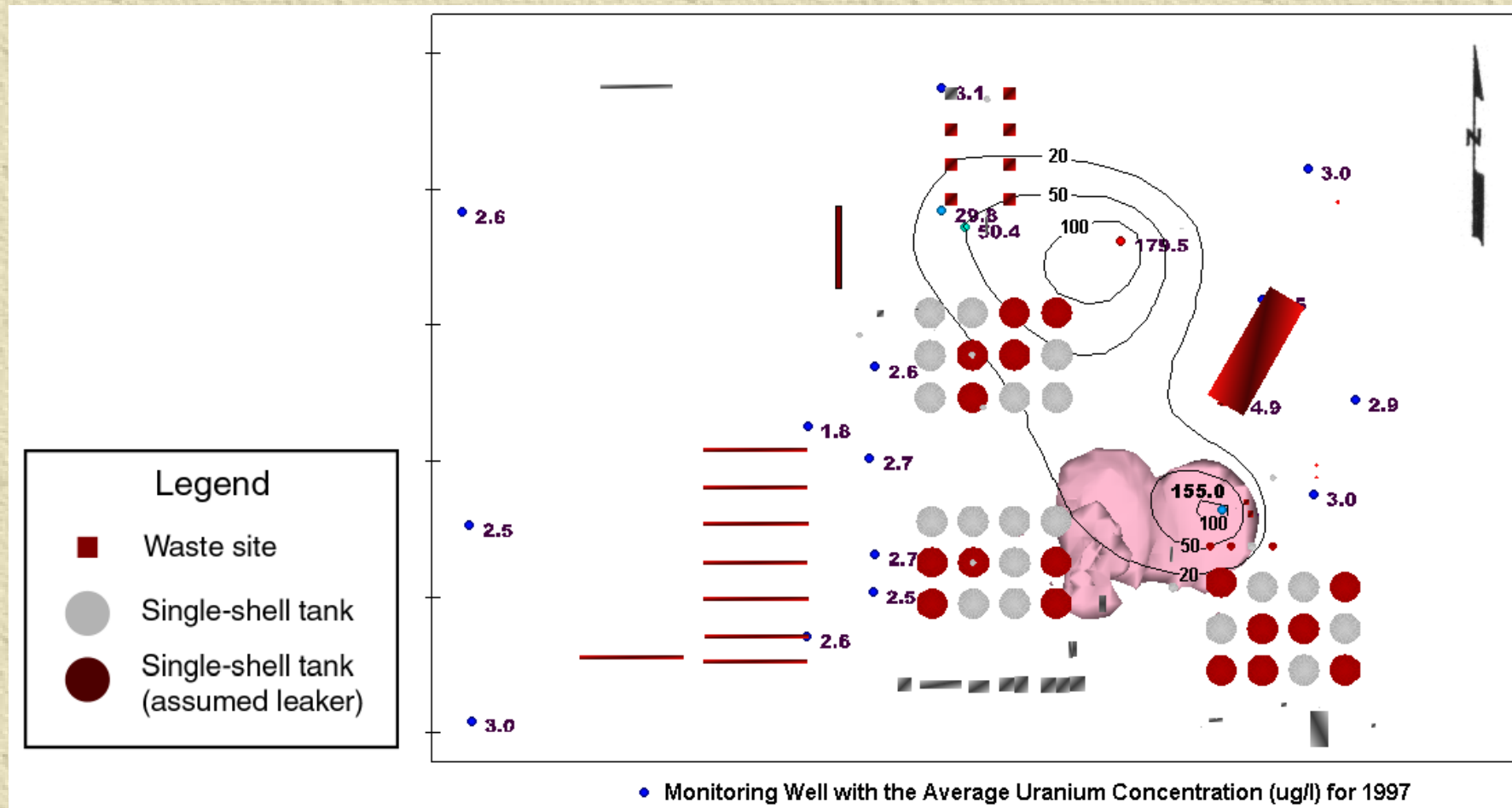


# Uranium Concentrations in Groundwater Samples From Wells in Vicinity of B-BX-BY Waste Management Area (PNNL 1998)

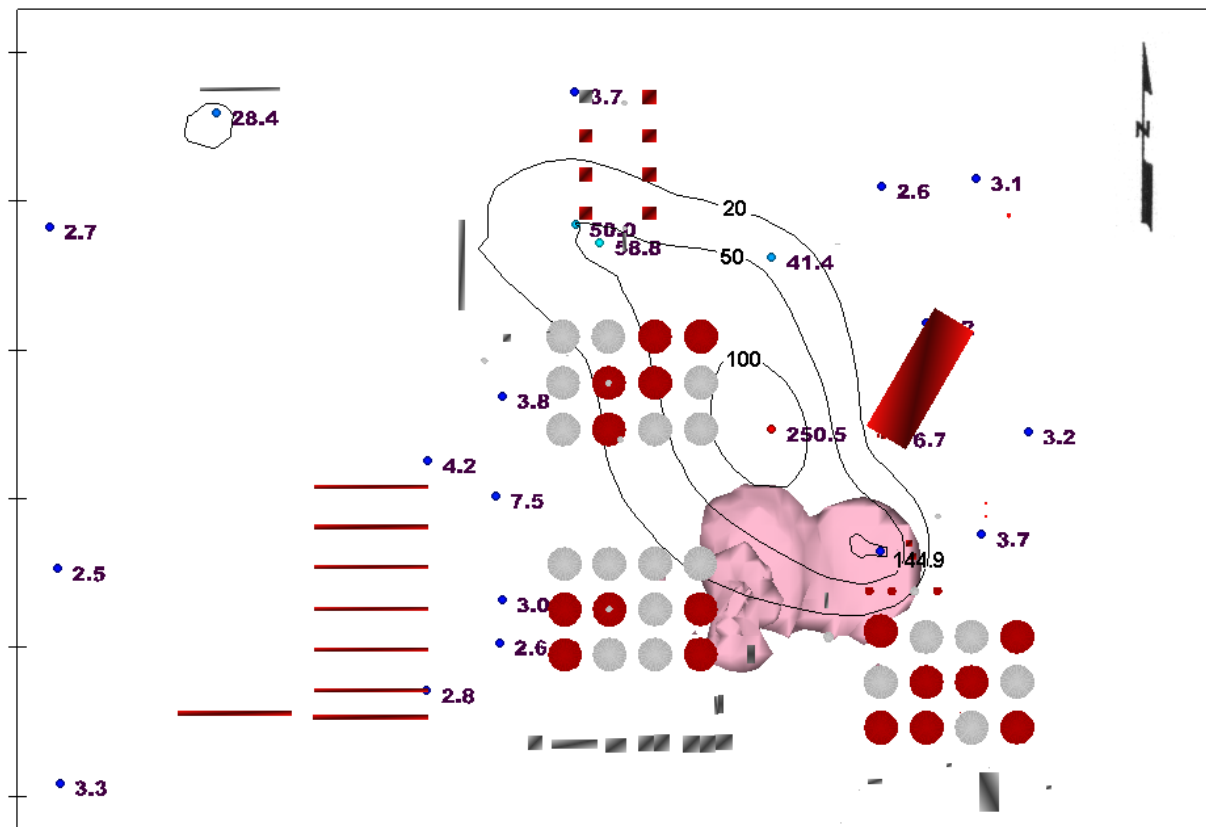




# Average Uranium Concentrations in Groundwater Samples in 1997 in B-BX-BY Waste Management Area (data from PNNL 2002)



# Average Uranium Concentrations in Groundwater Samples in 1998 in B-BX-BY Waste Management Area (data from PNNL 2002)

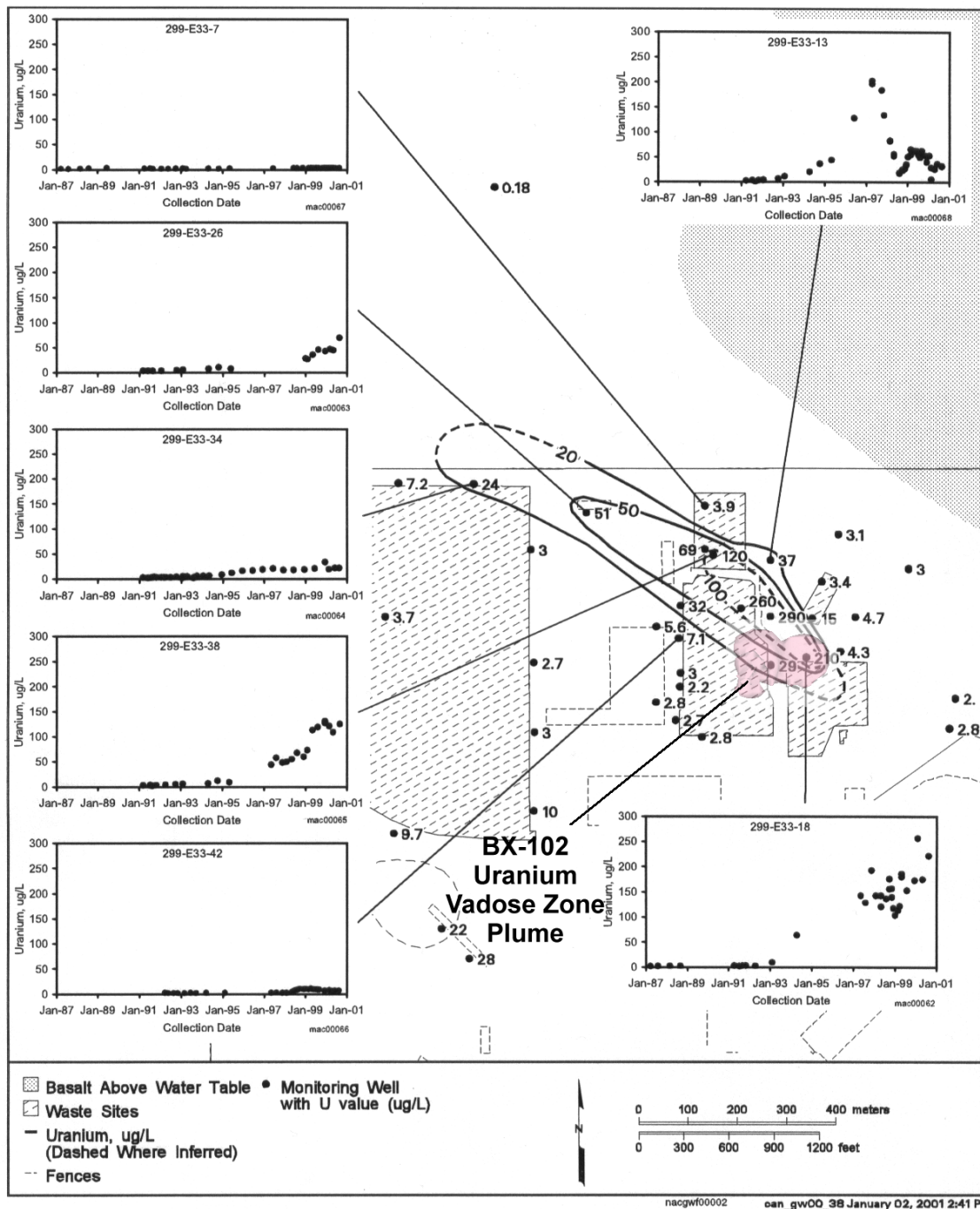


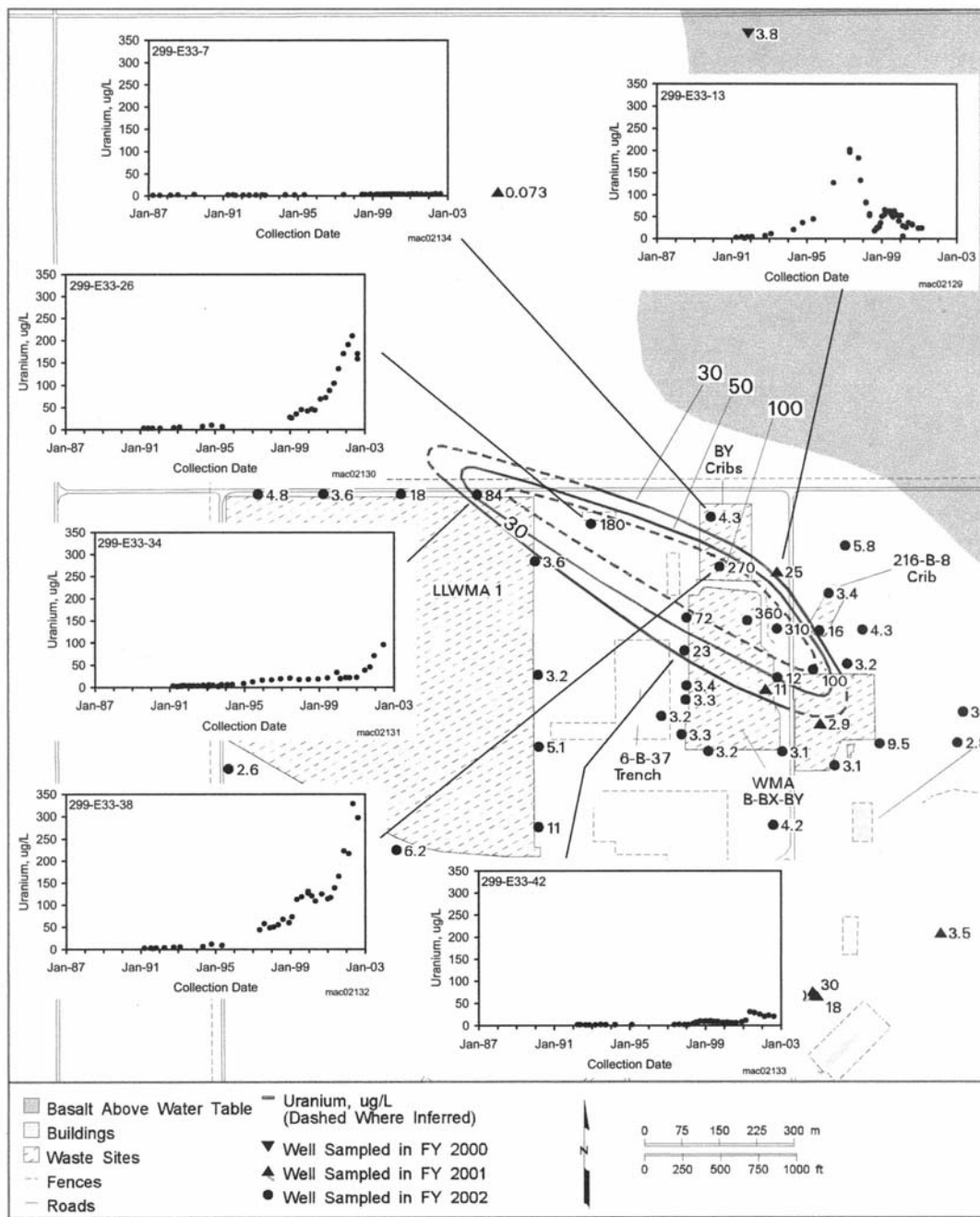
## Legend

- Waste site
- Single-shell tank
- Single-shell tank (assumed leaker)

● Monitoring Well with the Average Uranium Concentration (ug/l) for 1998

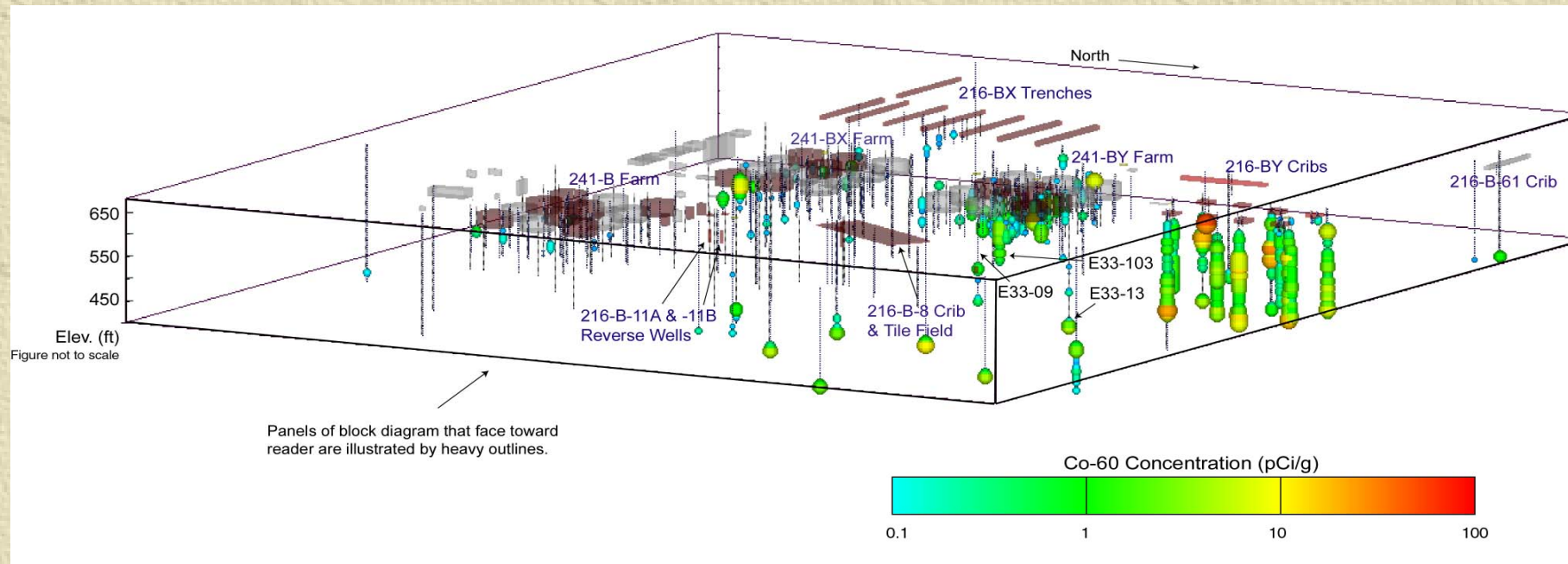
# Uranium Concentrations in Groundwater Samples in 2000 in B-BX-BY Area (modified from PNNL 2001)







# Subsurface $^{60}\text{Co}$ Distribution in B-BX-BY Waste Management Area and Surrounding Waste Disposal Facilities



# Conclusions

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- ✦ Log data of B-BX-BY Waste Management Area detected processed uranium only near tank BX-102 and in borehole 299-E33-59 (near 216-B-7B Crib)
- ✦ Based on log data, uranium concentrations in the deep vadose zone increased in boreholes 299-E33-41 and 299-E33-18 between 1991 and 1997
- ✦ First reported increase in uranium concentration in groundwater detected in samples from borehole 299-E33-18 in January 1994

# Conclusions (continued)

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- ✱ A southeast–northwest-trending uranium plume developed in the groundwater since 1994
- ✱ Uranium contamination originating at or near tank BX-102 traveled through vadose zone to northeast and entered the groundwater; uranium in groundwater moved northwest and probably reached groundwater underneath 216-B-61 Crib
- ✱ Sources of deep  $^{60}\text{Co}$  contamination detected in borehole 299-E33-9, underneath tank BY-103 (BY Tank Farm), and in borehole 299-E33-13 are tank leaks either in BY Tank Farm or in BY Cribs



# For More Information

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✠ Vadoso Zone Characterization Web Page

<http://www.gjo.doe.gov/programs/hanf/HTFVZ.html>

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